

Is Bioethanol from Corn Stover Sustainable?

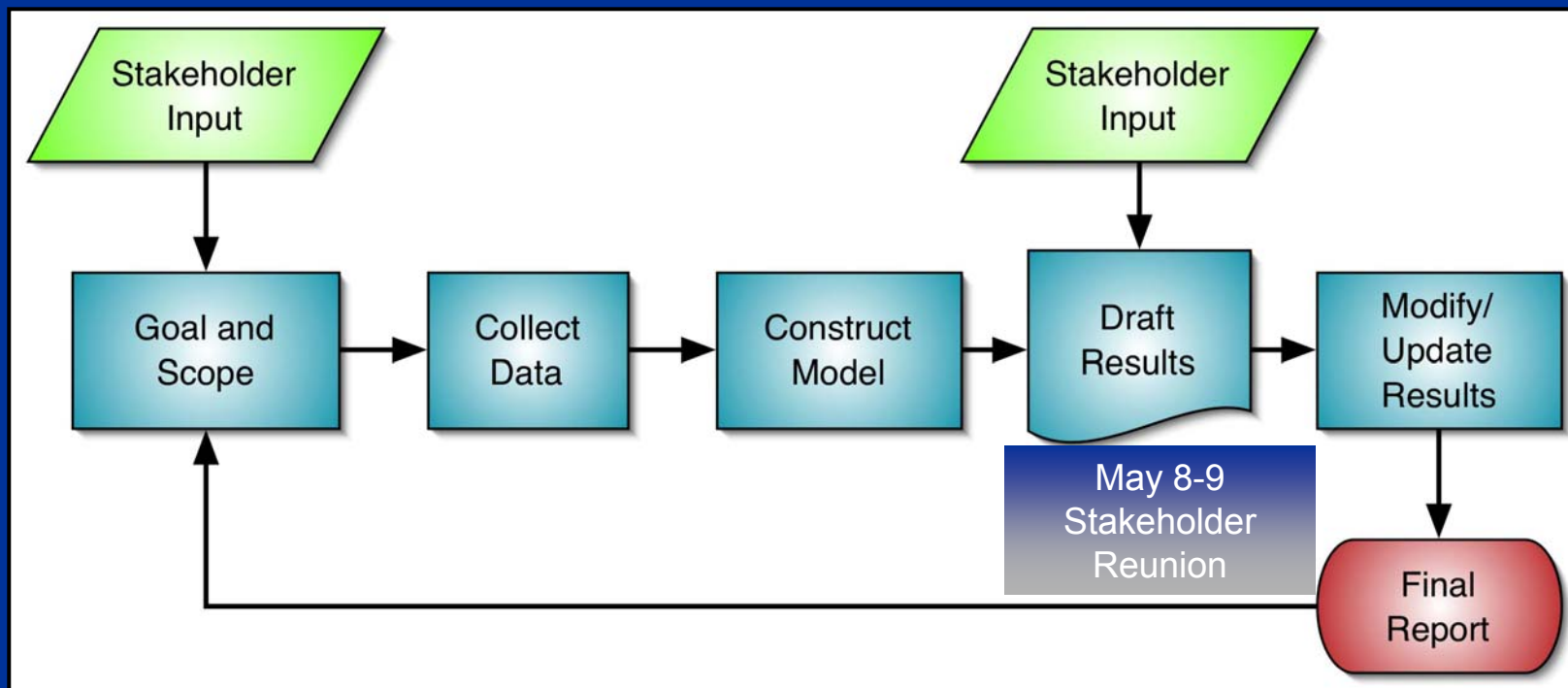
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Cynthia Riley
National Renewable Energy Laboratory

Stage Gate Criteria

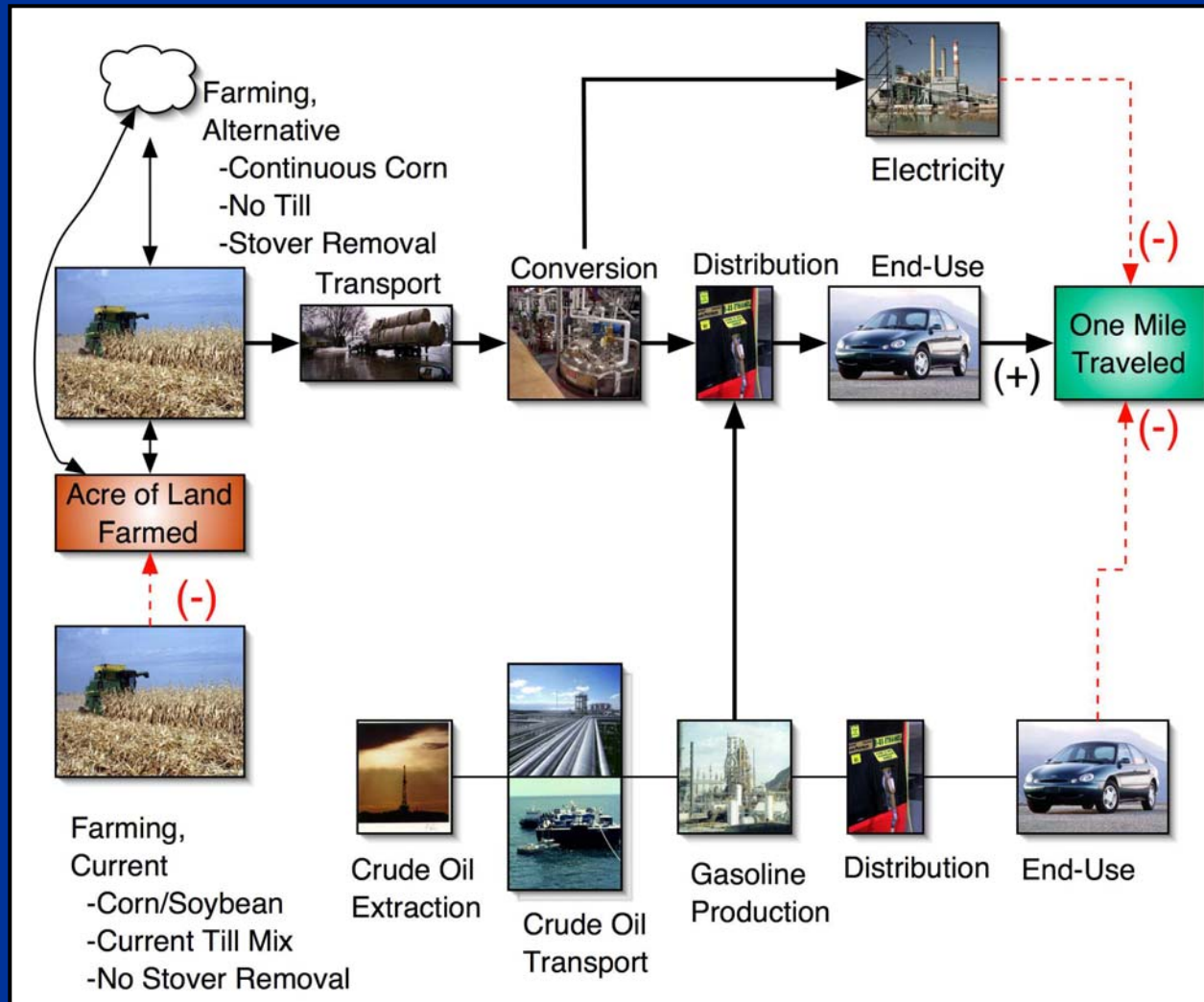
- Strategic Fit
 - Energy savings
 - Greenhouse gas emissions
 - Environmentally friendly
 - The rural economy
- Showstoppers/barriers
 - Is stover collection for ethanol really sustainable?
 - What happens to the land?
 - What does it mean to say that any energy supply is sustainable?
- Customer Needs
 - Previous feedback from industry identified the question of sustainability as critical to moving the bioindustry ahead

Life Cycle Analysis—A Tool for Dialogue

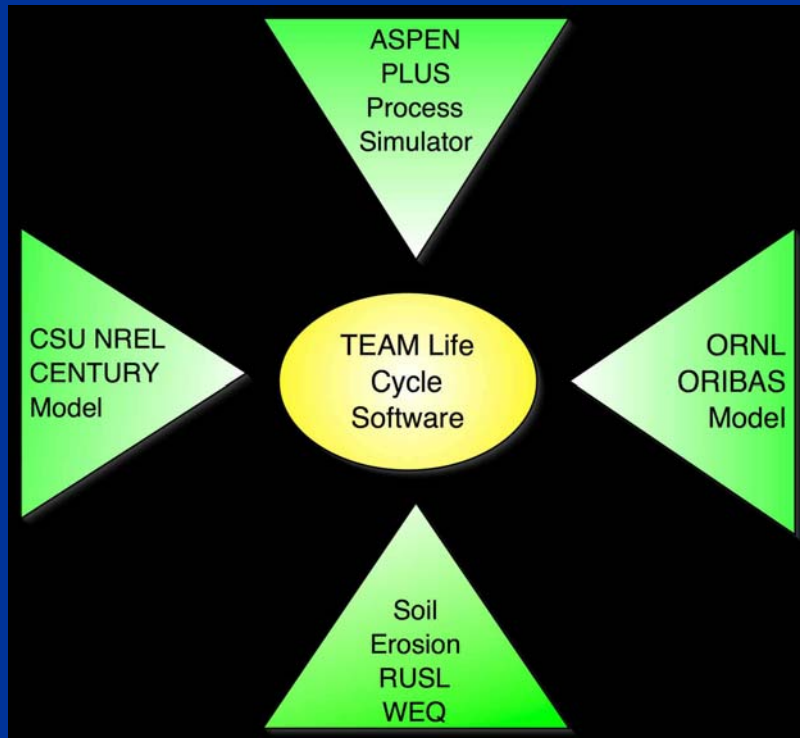


Involving stakeholders at the start and throughout such studies builds trust and confidence. It also helps to sort out the uncertainties of the science from the uncertainties of the moral and ethical choices we need to make.

Life Cycle Analysis—A Tool for Holistic Assessment

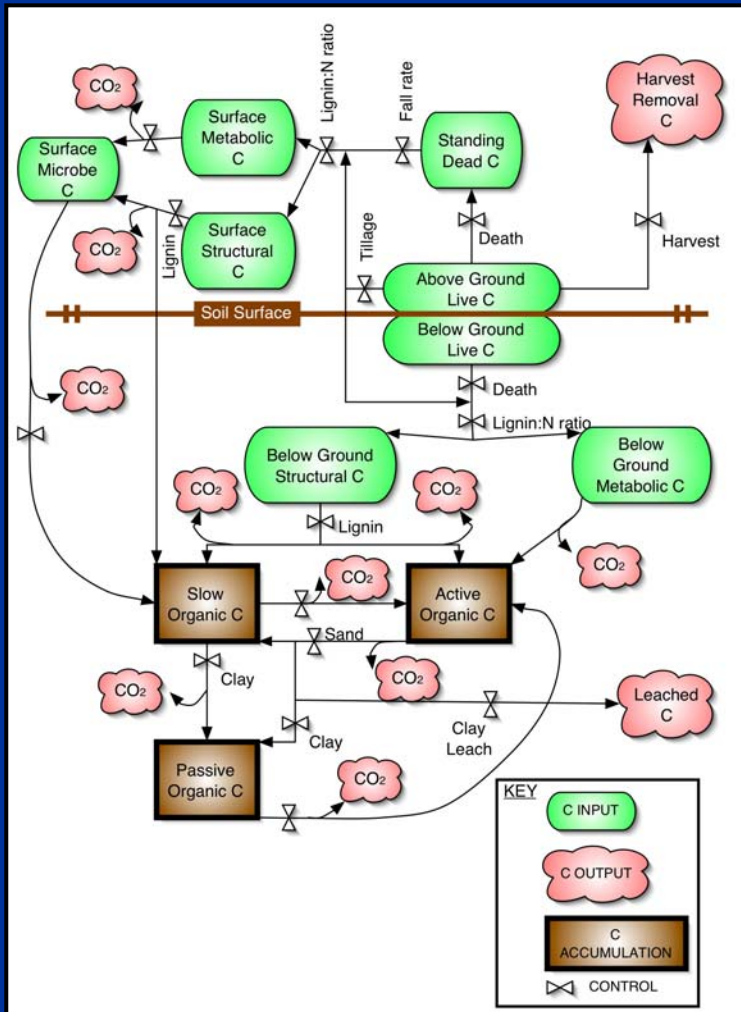


Life Cycle Analysis— Cyber-farming in Iowa



- ASPENPlus models the biorefinery
- ORIBAS models collection and logistics
- RUSL and WEQ model constraints on soil erosion
- CENTURY models soil carbon effects

Life Cycle Analysis— Cyber-farming in Iowa

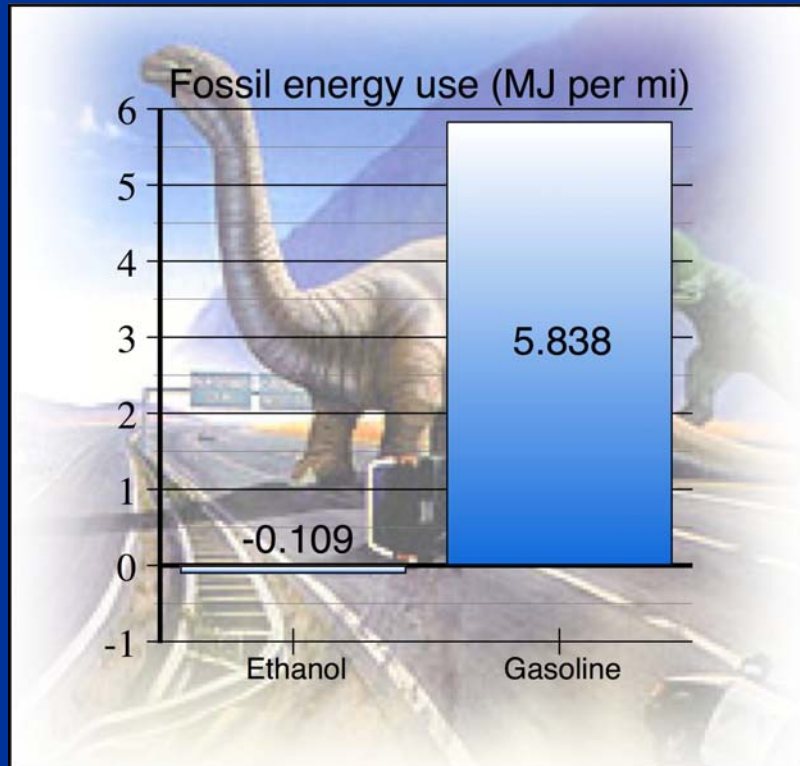


CENTURY Soil Organic Model provides an “agroecosystem” perspective on the effects that changes in farming have on soil carbon flows into and out of the soil

Stakeholder Input on Metrics for Sustainability

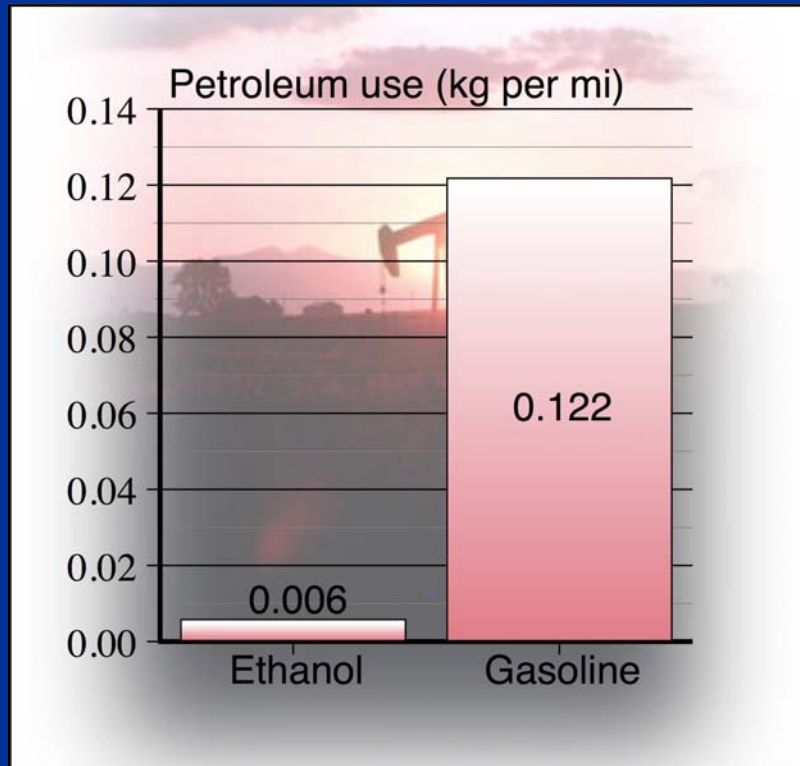
- Fossil energy avoidance
- Land use and biodiversity
- Greenhouse gas
- Soil sustainability
- Urban air emissions
- Air and water toxics
- Solid waste
- Eutrophication
- Acidification
- Community—rural jobs, local economy

Expanding Resources: Fossil Energy Savings



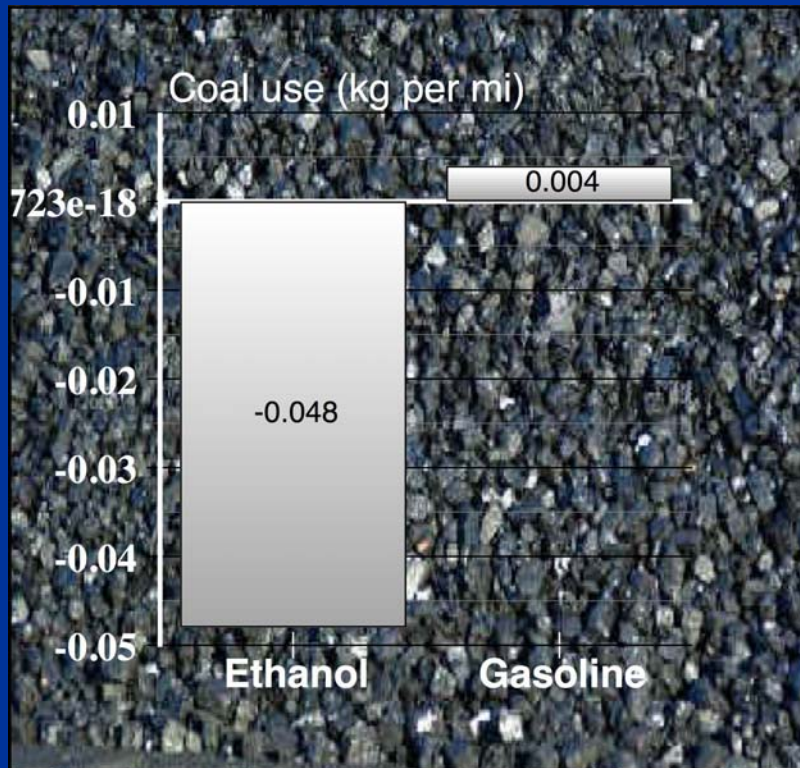
- For each mile driven on ethanol
 - The switch to bioethanol made from corn stover could reduce fossil energy consumption by 102%

Expanding Resources: Oil Savings



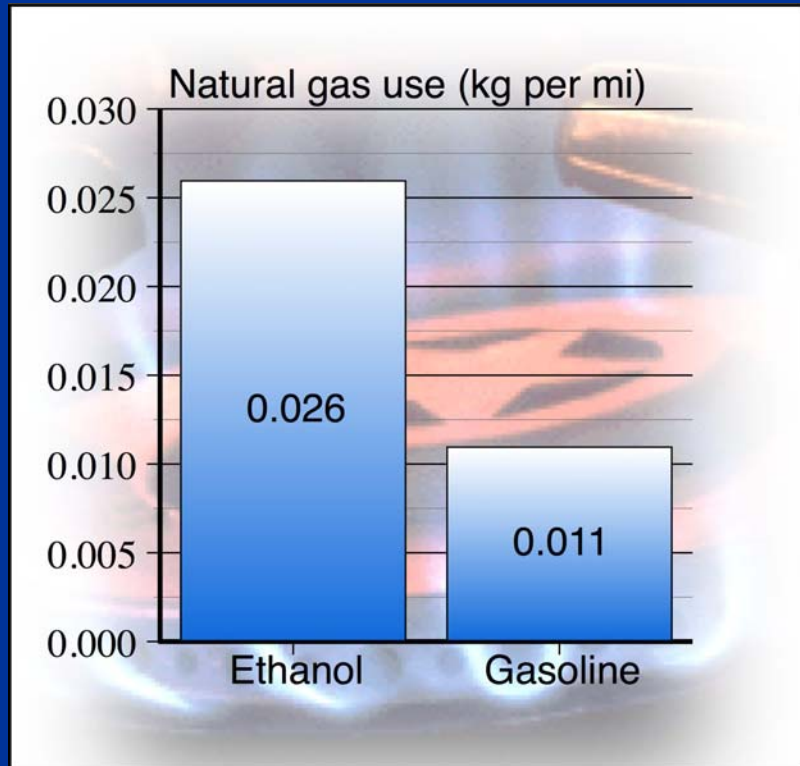
- For each mile driven on the ethanol fraction in the fuel
 - The switch to bioethanol made from corn stover could reduce oil consumption by 95%

Expanding Resources: Coal Savings



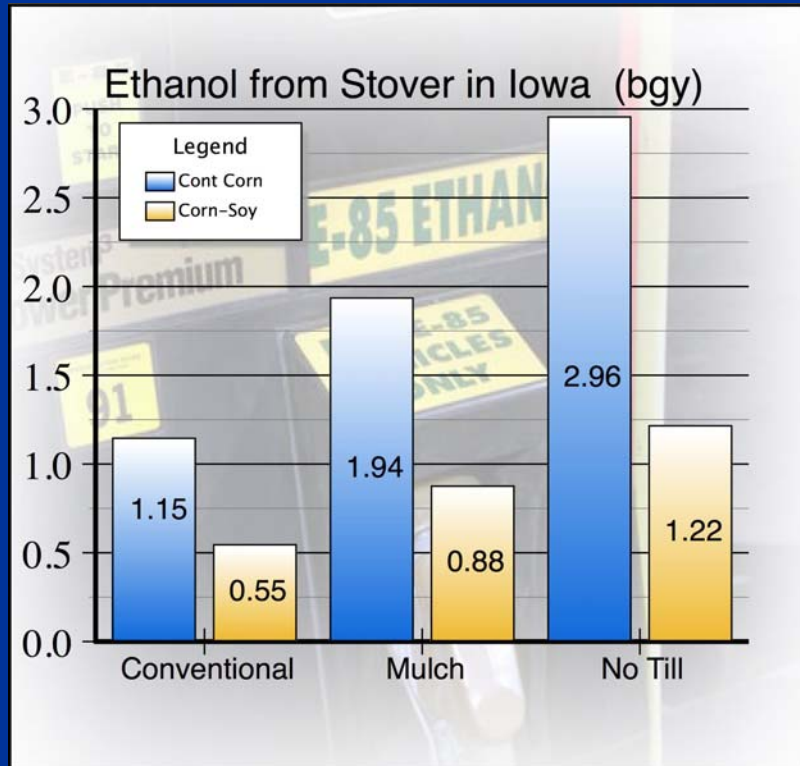
- For each mile driven on the ethanol fraction of the fuel
 - The switch to bioethanol made from corn stover could reduce coal consumption by 12-fold

Expanding Resources: Natural Gas Demand



- For each mile driven on the ethanol fraction in the fuel
 - The switch to bioethanol made from corn stover could increase natural gas use by 200%

Expanding Resources: How Much Fuel?



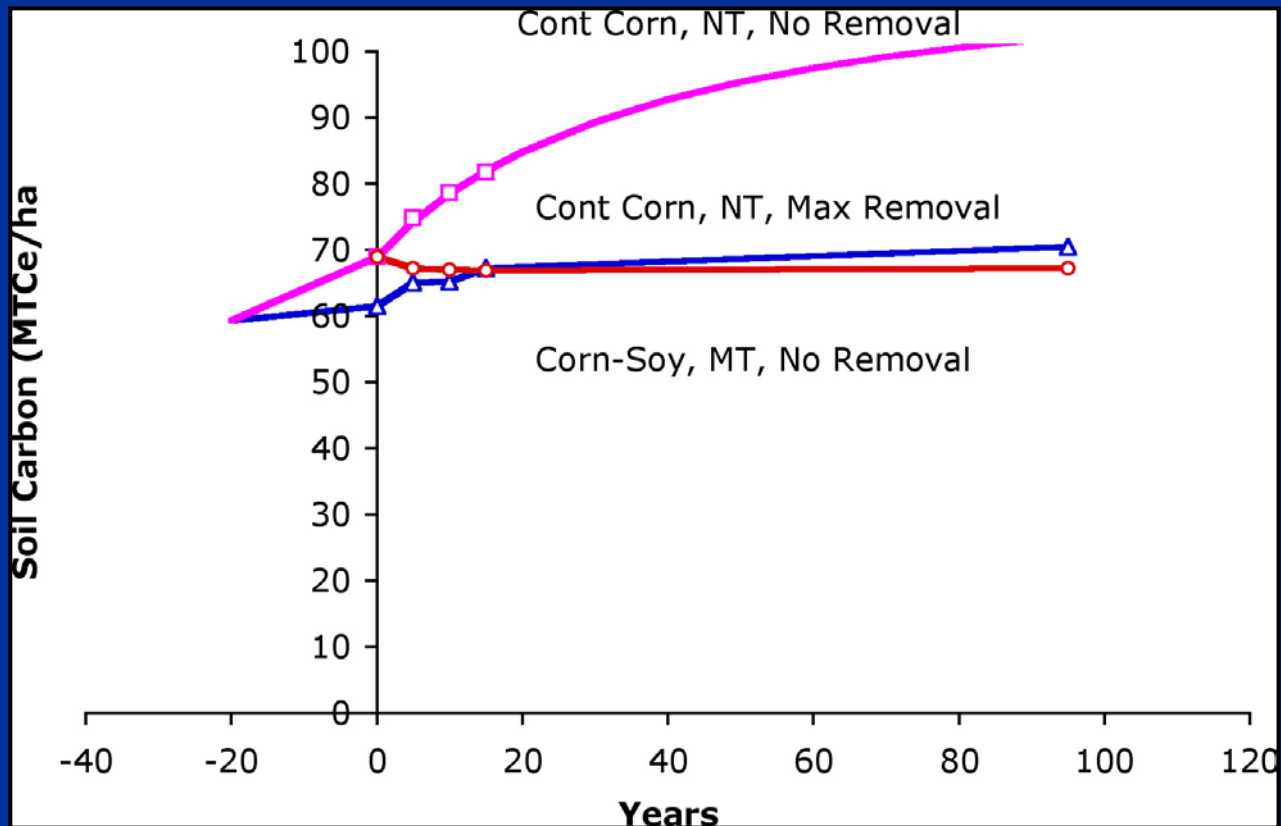
- Based on erosion limits, Iowa's stover could
 - supply 0.6 to 3 billion gallons of ethanol annually
 - displace 7.6 to 38 million barrels of crude oil per year

Quality of Life: Rural Economy

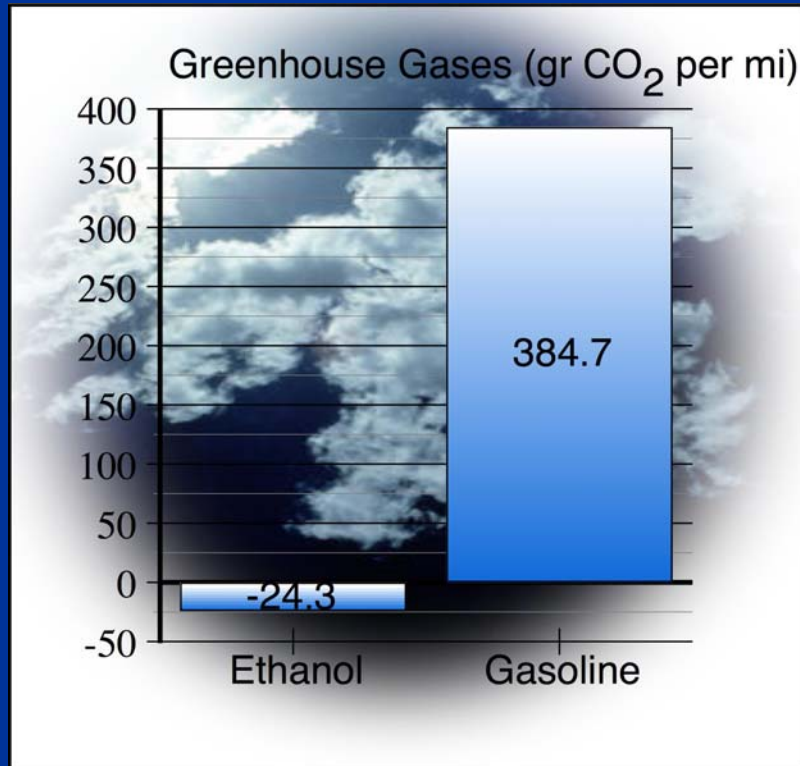


- Stover collection in two-pass system
- Farmers paid
 - \$10 per ton profit
 - Cost of fertilizer replacement and stover collection
- \$2.88 billion per year in direct revenues in Iowa for \$1.25 per gallon ethanol

Environment: A Scenario That Maintains Soil Carbon



Environment: Greenhouse Gas Emissions

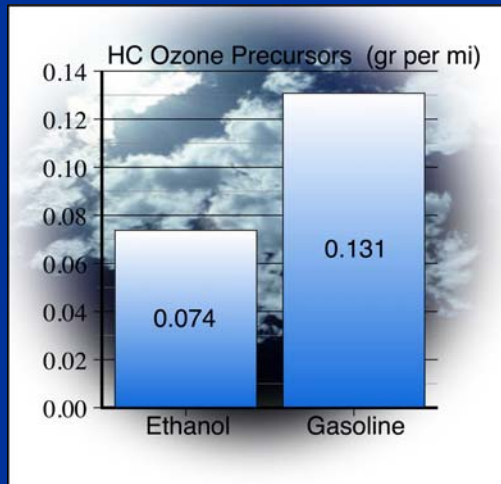


- Includes
 - Methane
 - Nitrous Oxide
 - Fossil CO₂
 - Soil CO₂
- For each mile driven on the ethanol fraction of the fuel
 - 106% reduction

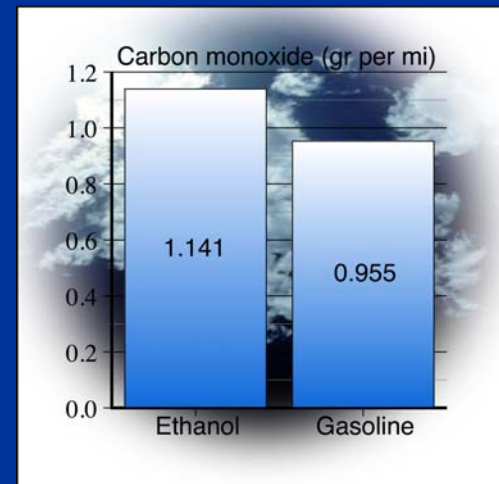
Environment:

Air Quality Impacts Are Mixed

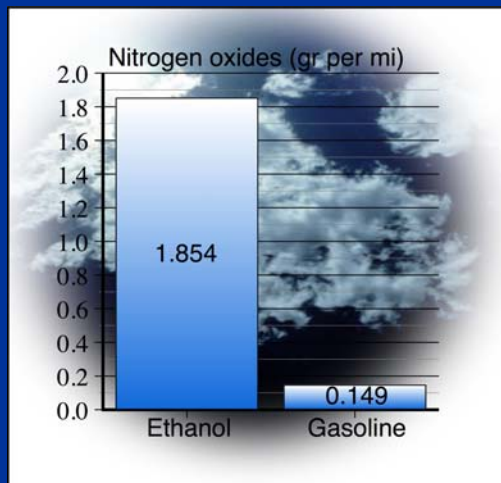
Ozone



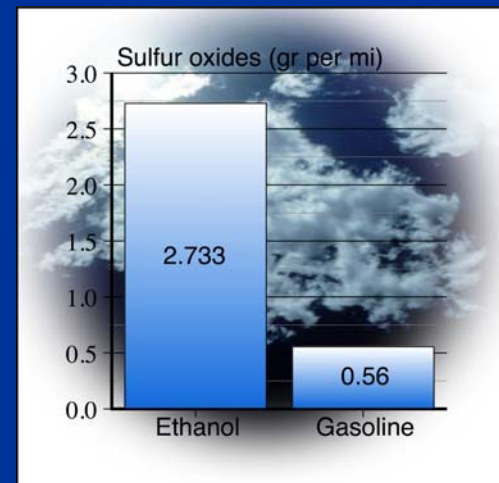
CO



NOx



SOx



Technology Risks: GMOs

- The question of what is acceptable risk has not been addressed in the U.S.



We Have Learned How to Look at Sustainability for Biomass



- Real buy in from USDA researchers on the methods
- Demonstrated a best case scenario for maintaining soil health
- Rural economic benefits
- Mixed air quality results

Next Steps



- Continue to build ownership of the basic agricultural sustainability questions at USDA
 1. Define, identify and model realistic and sustainable crop rotations
 2. Address water quality concerns
 3. Address broader national potential of stover and wheat straw as a resource